Overview of Thiabendazole

Revised Risk Assessment

Introduction

This document summarizes EPA's human health and ecological risk findings and conclusions for the pesticide thiabendazole, as presented fully in the document, "Thiabendazole and Thiabendazole salt: A Revised HED Risk Assessment for the Reregistration Eligibility Decision (RED) Document dated September 28, 2000, and EFED Reregistration Document for Thiabendazole, dated February 4, 1999. The purpose of this overview is to assist the reader by identifying the key features and findings of this risk assessment, and to better understand the conclusions reached in the assessment. This overview was developed in response to comments and requests from the public which indicated that the risk assessments were difficult to understand, that they were too lengthy, and it was not easy to compare the assessments for different chemicals due to the use of different formats.

The revised human health and ecological risk assessment for thiabendazole will be posted on the internet and placed in the Pesticide Docket on or about April 30, 2001, a 60-day public participation period on risk management will begin.

It has not been determined at this time if thiabendazole shares a common mechanism of toxicity with other substances or whether to include this pesticide with other cummulative risk pesticides. However, if the Agency does determine that this pesticide does share a common mechanism of toxicity with other pesticides, a cumulative risk assessment will need to be conducted to evaluate the risk from food, water, and non-occupational exposure resulting from all uses of thiabendazole. Currently, the Agency is developing the draft methodology needed to conduct such an assessment with guidance/advice provided by the Science Advisory Panel. It is anticipated that this draft methodology will be available for public comment and scientific review in the late summer/early fall of 2001. Consequently, the risks summarized in this document are only for thiabendazole.

Use Profile

- **Fungicide**: Thiabendazole (TBZ) has post-harvest uses on orchard crops (citrus, pome fruits, tropical fruits), potatoes, carrots, beans, and sugar beets, and avocados It is also used in mushroom houses, as a seed treatment (soybeans, wheat, potato seed pieces, chick peas, and dry beans), tobacco preservative, in-can paint preservative, and preservative of applied films. Thiabendazole salt uses include ornamental, elm and sycamore trees and as

a preservative in adhesives, coatings, paper, textiles, and paints.

- **Formulations:** **Thiabendazole base**: is formulated as a ready-to-use (0.1 to 50% ai), Flowable Concentrate (0.35 to 98.5% ai), Dust (0.5 to 98.5%), Emulsifiable Concentrate (0.1 to 98.5% ai), Wettable Powder (98.5% ai), Granular (89% ai), and Water Dispersable Granules (42.28% ai - SLN only). **Thiabendazole hypophosphorous salt**: is formulated as a 26.6% ai soluble concentrate and a 20% ai RTU.

- **Methods of Application:** Applied directly to seed as a pre-planting application dust (potato seed-pieces, soybean seed treatment or wheat seed treatment), chemigation (mushroom), foliar (cantaloupe, strawberry), or post-harvest applications by dipping, spraying, or application during the waxing procedure for fruits and avocados. TBZ can also be applied aerially (fixed wing or helicopter), and by ground boom.

- **Use Rates:** Use rates vary depending on the crop:
  - Average application rate for potato seed pieces: .005 lbs./100 lbs.;
  - Average application rate for mushroom spraying: 0.12 lbs.ai/500 ft^2;
  - Average application rate for post-harvest treatment to fruit: 0.054 lbs. ai/hr.; 2000 boxes/hr. Boxes weigh approximately 9 lbs. each.
  - Average application rate to paints and surfaces: 5g/2218 gal; 2 gal/day
  - Average application rate for wheat seed treatment: 0.25-0.36 oz.ai/100 lbs.

- **Registrant:** Syngenta is the manufacturer of thiabendazole.

Human Health Risk Assessment

Acute Dietary (Food) Risk

Acute dietary risk is calculated considering what is eaten in one day (in this instance, the individual who consumed the most) and maximum, or high-end residue values in the food. A risk estimate that is less than 100% of the acute Population Adjusted Dose (aPAD) (the dose at which an individual could be exposed on any given day and no adverse health effects would be expected) does not exceed the Agency's risk concerns.

- **Estimated acute dietary exposure for thiabendazole exceeds the Agency's level of concern for infants and children 1-6 years old at the 99.9th percentile.**

Table 1. Thiabendazole: Acute Dietary Risk % aPAD at 99.9th Percentile

Population Subgroup	% aPAD Consumed
General U.S.	57
Children (1 to 6 years)	117
Females 13+	53

- Two acute dietary endpoints were chosen, one for females 13+ and the other for the general population. A developmental rat study was used for both endpoints. TBZ produced decreased fetal body weight (5-7%) at doses of 30 and 80 mg/kg/day for the 13+ females population, and produced decreased maternal body weight seen during gestation for the general population at 40 and 80 mg/kg/day. For both endpoints, the NOAEL is 10mg/kg/day, and the LOAEL is 40 mg/kg/day.

Table 2. Acute Toxicity Endpoint

Acute Toxicity Endpoint			
Exposure Scenario	**DOSE**	**ENDPOINT**	**STUDY**
Acute Dietary (females 13+)	NOAEL=10mg/kg/day LOAEL= 40mg/kg/day UF = 100 FQPA SF = 1X	Decreased fetal body weight (females 13+)	Developmental Study - Rat
Acute Dietary (general pop.)	NOAEL =10mg/kg/day LOAEL =40mg/kg/day UF = 100 FQPA SF = 1X	Decreased maternal body weight seen during gestation (general pop.)	Developmental Study - Rat
aPAD (females 13+) = 0.1 mg/kg/day aPAD (general pop.) = 0.1 mg/kg/day			

- The 1996 Food Quality Protection Act (FQPA) requires the Agency to apply an additional safety factor of 10 during its risk assessment as a special protection for infants and children. The 10X safety factor was reduced to 1X based on the: 1) completeness of the toxicology database; 2) lack of evidence of increased susceptibility following pre-, and post-natal exposures; and 3) the use of adequate data (actual, surrogate and/or modeling outputs) which do not underestimate dietary and non-dietary exposures.

- Uncertainty factor (UF) is 100. 10X for interspecies extrapolation and 10X for intraspecies variability.

- The acute RfD (General Population and Females 13+) is calculated to be = 0.1 mg/kg/day. The acute Population Adjusted Dose (aPAD), which is equal to the RfD/FQPA factor is also 0.1 mg/kg/day.

- The Dietary Exposure Evaluation Model (Deem) which incorporates consumption data generated in USDA's Continuing Surveys of Food Intakes by Individuals (CFII), 1989-1992, was used to assess the dietary risk. For this acute dietary risk assessment, the entire distribution of single day food consumption events was combined with a distribution of residues to obtain a distribution of exposure in mg/kg/day. This is referred to as a probabilistic or "Monte Carlo" analysis and risk is calculated at the 99.9th percentile of exposure.

- The acute dietary risk analysis has been highly refined with: 1) the use of percent crop treated information (%CT); 2) Pesticide Data Program (PDP) data from USDA; 3) use of field trial data; and 4) calculated livestock anticipated residues. Residue inputs for commodities (avocado, mango, papaya and strawberry) from outside the U.S. used field trial residue values from specific use patterns. (See Table 5. for anticipated residues for acute and chronic dietary exposure analyses.)

Chronic Dietary (Food) Risk

Chronic Dietary risk is calculated by using the average consumption value for food and average residue values on those foods over a 70-year lifetime. A risk estimate that is less than 100% of the chronic PAD (cPAD) (the dose at which an individual could be exposed over the course of a lifetime and no adverse health effects would be expected) does not exceed the Agency's risk concern.

- **The chronic dietary risk for thiabendazole does not exceed the Agency's level of concern. Calculated aniticipated residues result in a maximum risk estimate of 2% of the chronic PAD (%cPAD) for children 1-6 years. Dietary risk estimate for the general US population was estimated to be 1% cPAD.**

Table 3. Thiabendazole Dietary Risk % cPAD.

Population Subgroup	% cPAD Consumed
General U.S.	1
Children (1 to 6 years)	2

- Endpoint is based on decreased body weight gains and liver hypertrophy in both sexes in the two-year chronic dog feeding study. The NOAEL = 10 mg/kg/day. The LOAEL = 30 mg/kg/day.

Table 4. Thiabendazole: Chronic Toxicity Endpoint

Chronic Toxicity Endpoint			
Exposure Scenario	**DOSE**	**ENDPOINT**	**STUDY**
Chronic Dietary	NOAEL=10 mg/kg/day	Decreased body weight gains and liver hypertrophy	2-Year Feed chronic carcinogenicity
	UF=100 FQPA=1X	Chronic PAD=0.1 mg/kg/day	

- Uncertainty Factor is 100. 10X for interspecies extrapolation and 10X for intraspecies variability.
- The FQPA Safety Factor = 1X
- The chronic Population Adjusted Dose (cPAD) is calculated to be 0.1 mg/kg/day.
- The highly refined risk assessment was conducted using: 1) percent (%) crop treated; 2) PDP monitoring data; 3) field trial data and; 4) calculated livestock anticipated residues.
- The most exposed subgroup is children 1-6 years, with 2% of the population adjusted dose consumed.

Table 5. Anticipated Residues for Acute and Chronic Dietary Exposure

Commodity/ Reassessed Tolerance (ppm)	**Max. % Crop Treated**	**Source**	**Commodity Classification**	**Food Form**	**Acute AR**	**Chronic AR***
Apples/5	62	PDP	NB	Uncooked, cooked, baked, boiled, fried	NA	0.517
		PDP	B	Dried	0.517	0.517
Pears/5	90	PDP	NB	Uncooked, cooked, baked, boiled	NA	0.379
		PDP (apple juice)	PB	Juice	NA	0.076
		PDP	B	Dried	.379	0.379
Bananas/3	50	PDP	NB	Uncooked, cooked, baked, boiled, fried	NA	0.044
			B	Dried	0.044	0.044
Carrots/10	1	PDP	NB	Uncooked, cooked, baked, boiled	NA	0.00026

Oranges/10	75	PDP	NB	Peeled fruit-uncooked, cooked	NA	0.117
			PB	Juice	NA	0.019
Limes/10	48	PDP (oranges)	NB	Peeled fruit-uncooked, cooked	NA	0.110
Grapefruit/10	45	PDP (oranges)	NB	Peeled fruit-uncooked, cooked	NA	0.110
Lemons/10	5	PDP (oranges)	NB	Peeled fruit-uncooked, cooked	NA	0.110
Potatoes/10	50	PDP	NB	White-peeled and white whole: uncooked, cooked, baked, boiled, fried, white peel only	NA	0.079
			B	White-dry	0.079	0.079
Mushrooms/40		FT	PB	All food forms	NA	15.2 5.86 irrigation trials
Sweet Potatoes/0.05	25	PDP	PB	Canned	NA	0.004
Wheat/0.2	1%	PDP	B	All food forms	NA	0.0001
Avocado/10	37% imported	FT	NB	All food forms	NA	3.70
Cantaloupe/TBD	29% imported	PDP	NB	Cantaloupe pulp	NA	0.026
Mango/10	100% imported	FT	NB	Cooked, uncooked and canned	NA	3.94
Papaya/5	100% imported	FT	NB	Cooked, uncooked and canned	NA	3.77
Soybeans/0.1	default 100% CT	PDP	B	All food forms	0.003	0.003
Crop Group 6AandB	default 100% CT	PDP	PB	Beans-succulent, peas (garden)-green, peas (garden)-succulent, snowpeas	NA	0.003
		PDP	B	Beans-dry	NA	0.003
Strawberry/5	7% imported	FT	PB	All food forms	NA	1.61

Goat Kidney, Goat MBYP, Goat other organ meats, Sheep Kidney, Sheep MBYP, Sheep other organ meats, Beef & Veal MBYP, Beef and Veal other organ meats, Beef and Veal Kidney/0.4	50%	FT	NB	All food forms	NA	0.068
Goat Liver, Sheep Liver, Beef & Veal Liver/0.4	50%	FT	NB	All food forms	NA	0.034
Pork MBYP/Pork other organ meats/Pork Kidney/0.4	50%	FT	NB	All food forms	NA	0.010
Pork Liver/0.4	50%	FT	NB	All food forms	NA	0.004
Milk/0.1	50%	PDP	PB	All food forms	NA	0.004

FT= Field Trial Data
PB= Partially Blended
NB= Not Blended
***** %crop treated calculated into anticipated residue.
NA = not applicable because the entire residue distribution was used.

Cancer Dietary Exposure Assessment

The Agency concluded that thiabendazole was carcinogenic in male and female rats because a treatment-related increased incidence of thyroid follicular cell adenoma was noted in the mid- and high-dose males, and high-dose females. There was also increase in the combined incidence of adenomas/carcinomas in males. These increases were statistically significant as in comparison to the controls. Thyroid tumors were considered by the Agency to be treatment-related because of the progressive nature of the tumor and evidence of dose-response. In the mouse carcinogencity study, administration of thiabendazole in the diet was not associated with a significant increase in thyroid tumors. Although, there was dose-related increase in mortality in both sexes at mid and high dose at 18 months, sufficient number of animals survived to assess the carcinogenic response. The Agency concluded that thiabendazole is not carcinogenic to mice, and that an MOE approach is appropriate to assess dietary risk. In addition, the Agency concluded that the chemical disruption mode of action of thiabendazole in animals, to the extent that it is applicable to humans, appears equally applicable to all human population subgroups. Children, therefore, are not expected to be more susceptible to thiabendazole-induced thyroid effects than adults.

- Thiabendazole induced thyroid tumors in both sexes of the rat. Thiabendazole also caused increased liver weight and and heptocellular hypertrophy presumably via induction of microsomal enzymes.

- Thiabendazole is not a mutagen. The lack of mutagenicity corroborates the notion that the thyroid tumors are induced by a non-mutagenic mechanism.

- Thiabendazole may interfere with thyroid-pituitary homeostasis, which involves the disruption of equilibrium between the balance of thyroid and pituitary hormones. The chemical disruption mode of action of thiabendazole in animals, to the extent that it is applicable to humans, appears equally applicable to all human population subgroups. Children, therefore, are not expected to be more suseptible to thiabendazole-induced thyroid effects than adults.

- Use of USDA PDP monitoring data, field trial data and calculated livestock anticipated residues (ARs) results in a Margin of Exposure (MOE) of 9,750 for the general US population.

Drinking Water Dietary Risk

People can be exposed to pesticides through consumption of contaminated drinking water; therefore, EPA considers both acute (one day) and chronic (lifetime) drinking water risks. To estimate exposure, EPA uses either monitoring data or modeling values to estimate pesticide concentrations in drinking water. Although monitoring data is preferred, it is not available for most pesticides. Concentrations estimated by modeling are considered to be unrefined and provide a high end estimate of exposure. To determine the maximum allowable concentration of pesticides in water, EPA first calculates the contribution of pesticides in food items and considers the amount of water consumed and subtracts this amount from the PAD to determine a drinking water level of comparison.

Since no thiabendazole water modeling data were available, the EPA estimated thiabendazole concentrations with Tier 1 screening models: SCI-GROW for ground water sources and GENEEC for surface water sources. Concentrations were estimated for wheat seed treatment at a maximum of one annual application of 3.6 ounces of ai/100 pounds of seed or 0.2 lbs. ai/A.

- For groundwater, SCI-GROW reports 0.01 ppb for thiabendazole residues, based on the maximum application rate. This is expected since thiabendazole does not seem to significantly leach into groundwater, due to its high soil/water partitioning coefficients. Terrestrial field studies report low leaching potential of this chemical in the fields, as thiabendazole was not detected in any of the soil samples below the 12 inch depth.

- Surface water GENEEC acute values are approximately 2.5 ppb.
- Surface water GENEEC chronic values are approximately 0.5 ppb.
- No data were available for thiabendazole degradates. However, due to the slow degradation of TBZ, the degradates are not expected to be present at levels which would be harmful.
- Most use scenarios of thiabendazole, such as post-harvest treatments will not result in exposure to water. Mushrooms and wheat seed treatment were assessed as the uses most likely to impact water.
- Thiabendazole use on mushrooms does not raise any drinking water concerns because treatment is performed indoor. Treatment to wheat seeds also takes place indoors, but since the treated seeds are later planted in the field, potential drinking water exposure was assessed.
- Overall, the Agency believes that thiabendazole use on wheat will not present any significant contamination to either surface water or groundwater resources.

Acute Exposures

- Acute DWLOC's were calculated based on the acute dietary exposure and default body weights and water consumption figures. The EECs for surface water (GENEEC) were less that the acute DWLOCs except for Children 1-6 years indicating that acute aggregate exposure to thiabendazole in food and water is not of concern for most populations.
- The EECs for groundwater (SCI-GROW) were less than the acute DWLOCs except for Children 1-6 years indicating that acute aggregate exposure to thiabendazole in food and water is below the Agency's level of concern for all populations except children 1-6 years.

Table 6. Acute DWLOC Values Compared to Modeling Estimates:

Acute	Food Acute (99.9th) % aPAD	Acute DWLOC	Acute EEC	
			Surface (model)	Ground (model)
U.S. Population	57	1500	2.4 ppb	0.01 ppb
Children (1 to 6 years)	117	exceeds level of concern based on food alone		

Chronic Exposures

- The EECs for surface water (GENEEC) were less than the chronic DWLOCs, indicating that chronic exposure to thiabendazole in food and water is below the Agency's level of concern.
- The EECs for groundwater (SCI-GROW) were less than the chronic DWLOCs, indicating that chronic exposure to thiabendazole in food and water is below the Agency's level of concern.

Table 7. Chronic DWLOC Values Compared to Modeling Estimates:

Chronic	Food Chronic (99.9th) % cPAD	Chronic DWLOC	Chronic EEC	
			Surface (model)	Ground (model)
U.S. Population	1	3500 ppb	0.5 ppb	0.01 ppb
Children (1 to 6 years)	2	3000 ppb	0.5 ppb	0.01ppb

Cancer Exposure

- Cancer DWLOCs were not calculated since the MOE approach was used to estimate the cancer dietary (food) exposure. However, the predicted EEC from GEENEC will result in <1% of the exposure from food alone.

Residential Risk

Due to thiabendazole's use profile, the Agency has determined that there is low potential for residential exposure. The low concentrations of thiabendazole in paints, adhesives, paper and carpet greatly reduce the potential for exposure. Worst case scenarios are described for residential exposure to thiabendazole following incorporation into carpet.

There are no chemical-specific exposure data for thiabendazole. The Agency used either surrogate data from the scientific literature, PHED and/or modeling techniques for all the exposure scenarios.

Residential handler dermal and inhalation exposures include use of latex or oil base paint formulations containing thiabendazole. Residential exposure may also include exposure to carpet, textile and paper treated with thiabendazole.

Table 8. Summary of Residential and Occupational Endpoints

EXPOSURE SCENARIO	DOSE (mg/kg/day)	ENDPOINT	STUDY
Short-Term (Dermal and Inhalation)	NOAEL =10mg/kg/day LOAEL = 40mg/kg/day	Based on decreased fetal body weights	Oral Developmental Toxicity - Rat
Intermediate-Term (Dermal and Inhalation)	NOAEL = 10mg/kg/day LOAEL = 40mg/kg/day	Based on reduced body weight gains and histopathological changes in bone marrow, liver and thyroid	Fourteen Week Oral Toxicity (Feeding) Study
Dermal Absorption Factor = 60%		Inhalation Absorption Factor = 100%	

- The calculated dermal and inhalation risks were considered to be acceptable. 100-1000 for adults, 59-590 for toddlers and 39-390 for infants. Even though any value below 100 may be of concern, the exposure is thought to be an overestimate since thiabendazole is usually used as a preservative in the backing of carpet, and this assessment was done using exposure values from a spray to carpets.

- In all cases, residential exposure from carpet, textiles and paper, is not expected to exceed the Agency's level of concern.

- **Note: The estimates used by the Agency for post-application exposure to carpets are considered to be very conservative because the estimates were derived from a surface spray study, not a product that was treated with thiabendazole during manufacture. Thiabendazole is applied during manufacture and much of the material is likely to be bound to the backing of the carpet which is likely to be inaccessible. The residues measured were surface only. The Agency used the spray study because there are no exposure data available for thiabendazole. Therefore, the modeling data used are considered extremely conservative.**

Aggregate Risk

Aggregate risk looks at the combined risk from exposure through food, drinking water, and residential uses of a pesticide. Generally, all risks from these exposures must be less than 100% of the acute and chronic PADs to be considered acceptable.

The aggregate acute dietary risk estimates include exposure to thiabendazole residues in food and water and non-occupational exposure. The aggregate chronic dietary risk estimates include exposure to thiabendazole residues in food and water only.

Acute Aggregate Risk

- Acute aggregate risk is above the Agency's level of concern for children 1-6 years. Use of PDP monitoring data, field trial data and calculated livestock anticipated residues (ARs) resulted in estimated dietary exposure (99.9th percentile) corresponding to 57 % aPAD for the general US population and 117% aPAD for children 1-6 years old. Since food alone exceeds the Agency's level of concern, acute aggregate risk (food and water) was not calculated.

Chronic Aggregate Risk

- Aggregate chronic dietary risk estimates include exposure to thiabendazole residues in food and water. No chronic residential use scenarios were identified.

- Exposure (food only) to combined residues of thiabendazole and its metabolites of concern based on a highly refined (Tier 3) assessment using average residues from field trial data and percent crop treated PDP data, represent 2% of the cPAD for the most highly exposed population subgroup (children 1-6 years) and infants <1 year of age.
- Exposure to all other groups represents 1% of the cPAD.

- Using conservative screening-level models, the estimated average 56- day concentration of thiabendazole in surface water is 0.52 ppb. This estimated average concentration is less than the Agency's drinking water level of comparison for exposure to thiabendazole in drinking water as a contribution to aggregate chronic dietary risk.

- Chronic aggregate risk estimates do not exceed the Agency's level of concern.

Short-Term and Intermediate-Term Aggregate Risks

- Short-term and intermediate-term aggregate risks do not exceed the Agency's level of concern.

- Short-term and intermediate-term aggregate risks which include drinking water have been calculated using the reciprocal MOE equation to determine the DWLOC values for the U.S. population, infants, children and male and female subgroups:

- Two short-term and intermediate-term residential exposure scenarios were identified **for the adult population: dermal exposure to paints and treated carpets** were identified and calculated with exposure to dietary. **For infants and children, only the carpet exposure** was aggregated with average dietary exposure to calculate allowable contribution of thiabendazole residues from drinking water. MOEs calculated using lower bound estimates are all above 300, and do not exceed the Agency's level of concern.

- When upper bound estimates are considered for non-occupational exposure (treated carpet), in addition to dietary exposure, all population subgroups are found to exceed the Agency's level of concern. However, since these estimates are based on highly speculative assumptions which over-estimate exposure risks, use of the lower-bound estimates may be more accurate and realistic.

Cancer Aggregate Risk

The cancer MOE for the US General Population is 9,750. Estimated exposure from water is expected to be <190 of exposure from food. Therefore, cancer aggregate risk differs negotiations from food alone.

Occupational Risk

Workers can be exposed to a pesticide through mixing, loading, or applying a pesticide, and reentering a treated site. Worker risk is measured by a Margin of Exposure (MOE) which determines how close the occupational exposure comes to a No Observed Adverse Effect Level (NOAEL). Generally, for thiabendazole, MOEs greater than 100 do not exceed the Agency's risk concern.

EPA has determined that there are potential exposures to loaders, applicators, or other handlers for usual use-patterns associated with thiabendazole. Occupational thiabendazole exposure via dermal and inhalation routes can occur during the handling, mixing, loading, applying and post-application activities with thiabendazole-treated commodities. Thiabendazole may also be mixed with a wax formulation prior to application. Commercial seed treatment equipment is used for application to wheat and soybean seeds. Mushroom house treatments are multiple direct sprays. The thirteen (13) major exposure scenarios identified for thiabendazole are:

1) planting potatoes
2) observer on tractor planting potato pieces
3) filling duster for potato seed treatment/cutting potato seed pieces (3a-e)
4) manual seed treatment at farm

5) commercial seed treatment
6) mixing/loading for post-harvest treatments
7) exposure during post harvest handling of treated commodities
8) applying paints containing TBZ to surfaces using a paintbrush
9) applying paints containing TBZ to surfaces using an airless sprayer
10) application to mushroom houses
11) mixing/loading for mushroom houses
12) postapplication exposure to treated carpet, textiles, or paper (12a-c)
13) tree injection

- No chemical specific exposure data were available for any of the worker exposure assessments. Baseline dermal and inhalation exposure assessments were derived using surrogate data from the Pesticide Handlers Exposure Database (PHED), version 1.1

- In addition to risk estimates, thiabendazole ranks very low in the number of occupational incidents suggesting low potential for hazardous effects to humans.
- Thiabendazole use patterns show that both short-term (1-7 days) and intermediate-term (1 week to several months) exposure is possible.

- The same endpoints were used for the assessment of dermal and inhalation risks: a NOAEL of 10 mg/kg/day. Therefore, a risk assessment was conducted for combined short-term and intermediate-term dermal and inhalation exposures.

- Dermal absorption rate is 60%. This is based on comparison of an oral developmental toxicity study in rabbits (LOAEL =600 mg/kg/day), and a 21-day dermal toxicity study in rabbits (LOAEL > 1000 mg/kg/day).

- For worker risks, MOE's of 100 and above are acceptable for short-term dermal risk, intermediate-term dermal risk, and short-term and intermediate-term inhalation risk.

- The representative treatment scenarios considered for mixers, loaders, and applicators, and the associated application rates used are listed below.

- All worker risks are acceptable with PPE except manual seed treatment which already uses PPE.

Mixers/Loaders/Cutters

3a) Mixing/loading dust formulation for duster for potato seed pieces (**outside facility**) for clean seed
- .005 lbs. ai/100 lbs. of seed pieces, 30 Acres/day
- Baseline MOE = 120

3b) Mixing/loading dust formulation for duster for potato seed pieces (**outside facility**) for Rocky seed

- .005lbs. ai/100 lbs. of seed pieces, 30 Acres/day
- Baseline MOE = 222

3c) Mixing/loading dust formulation for duster for potato seed pieces (**inside facility**) for clean seed

- .005 lbs. ai/100 lbs. of seed pieces, 30 Acres/day
- Baseline MOE = 1300

3d) Mixing/loading/cutting dust formulation for cutting potato seed pieces (**complete operation inside)**

- .005 lbs. ai/100 lbs. of seed pieces, 30 Acres/day
- Baseline MOE =3400

3e) Mixing/loading/cutting dust formulation for cutting potato seed pieces (**cutter inside and duster outside)**

- .005 lbs. ai/100 lbs. of seed pieces, 30 Acres/day
- Baseline MOE = 14,000

6) Mixing/loading/ for post-harvest spray treatment of commodities

- .054 lbs. ai/hour of fruit, 16,000 boxes per day
- Baseline MOE = 910

11) Mixing/loading for mushroom spraying

- 0.12 lbs. ai/500 ft^2 per mushroom house
- Baseline MOE = 333

Applicators

8) Applying paints containing TBZ to surfaces, paintbrush

- 5g/gal.;2 gallons/day
- Baseline MOE = 290

9) Applying paints containing TBZ to surfaces, airless sprayer

- 5g/gal.;5 gallons/day
- Baseline MOE = 560

1) Planting potato seed pieces

- .005lb/100 lbs. of seed pieces; 30 Acres/day
- Baseline MOE = 3800

2) Observer on tractor planting potatoes

- .005 lbs./100lbs. of seed pieces
- Baseline MOE = 430

4) Manual seed treatment
   - .005 lbs./100 lbs. of seed pieces
   - MOE with gloves = 56

5) Commercial seed treatment
   - no data, not expected to exceed manual seed treatment

11) Application to mushroom houses
   - 0.12 lb ai/500 ft^2
   - Baseline MOE = 77; w/PPE MOE = 112

   PPE = single layer of clothing and gloves

Post Harvest and Post Application Exposures

7) Post harvest exposure during sorting/packing/culling
   - No application rate information
   - Baseline MOE = 32; w/PPE MOE = 320

Post-Application Occupational Risk

Because thiabendazole is applied as a post-harvest dip to citrus, pome fruits, mango, bananas, papaya, avocados and sugar beets, the Agency has concluded that there is a potential for occupational post-application exposure.

- requiring PPE reduces dermal exposures significantly resulting in MOEs for dermal/inhalation exposure risk were below the Agency's level of concern.

Ecological Risk Assessment

To estimate potential ecological risk, EPA integrates the results of exposure and ecotoxicity using the quotient method. Risk quotients (RQs) are calculated by dividing estimated exposure concentrations by ecotoxicity values, both acute and chronic, for various wildlife species. RQs are then compared to levels of concern (LOCs). Generally, the higher the RQ, the greater the potential risk. Risk characterization provides further information on the likelihood of adverse effect occurring by considering the fate of the chemical in the environment, communities and species potentially at risk, their spatial and temporal distributions, and the nature of the effects observed in studies.

Non-target Terrestrial Animal Risk

- Thiabendazole is practically non-toxic to birds and small mammals with LD_{50} values greater than 2000 mg/kg. Exposure is likely to be minimal due to a low application rate of (0.2 lb ai/A), acute risk is not expected from the use of thiabendazole as a seed treatment for wheat.

- Chronic risk is not expected. Chronic exposure should be minimal from a seed treatment use, and the available avian reproduction data indicate that chronic toxicity is not likely from such a low application rate as that for wheat seed treatment.

Non-target Aquatic Animal Risk

- Thiabendazole is highly toxic to fish and aquatic invertebrates. However, the Agency believes there will be minimal potential risk to aquatic animals resulting from the use of thiabendazole in mushrooms and wheat. As well, the Agency does not expect thiabendazole or its degradates to enter the drinking water resources at any significant level.

- No endangered species LOC has been exceeded. Therefore, no presumption of risk is made for any endangered species from the use of thiabendazole as a seed treatment on wheat.

Incidents

The Agency's Incident Data System contains very few reported incidents for thiabendazole. Two of three reports involve eye irritation. The Poison Control Center data for 1993-1996 contains nine (9) exposures to thiabendazole. Only two of the nine exposure resulted in a minor medical outcome, and three were potentially minor to moderate with no follow-up medical attention. None of the cases required hospitalization. The California Department of Food and Agriculture data indicate that from 1982 - 1996, only four cases of skin illness in packing/processing workers where thiabendazole was the primary pesticide responsible for the illness. One case required two days off from work. None of the cases were hospitalized. It appears as though exposure to thiabendazole can cause eye irritation and skin rashes and are short-lived. The Agency recommends the appropriate protective clothing be worn by occupational workers who may have extensive exposure from handling thiabendazole.

Public Comment Period

A formal 60-day public comment period, inviting all interested parties, and stakeholders an opportunity to comment on the thiabendazole revised risk assessment and risk mitigation ideas will be provided for in the near future. These comments will be submitted to the Agency's Public Docket office and all comments will be considered.